Chapter Comm 21

CONSTRUCTION STANDARDS

Note: Chapter Ind 21 was renumbered to be chapter ILHR 21, Register, February, 1985, No. 350, eff. 3-1-85. Chapter ILHR 21 was renumbered chapter Comm 21 under s. 13.93 (2m) (b) 1., Stats., and corrections made under s. 13.93 (2m) (b) 6. and 7., Stats., Register, January, 1999, No. 517.

Subchapter I — Scope

Comm 21.01 Scope.

The provisions of this chapter shall apply to the design and construction of all one- and 2-family dwellings.

Subchapter II — Design Criteria

Comm 21.02 Loads and materials.

Every dwelling shall be designed and constructed in accordance with the requirements of this section.

(1) DESIGN LOAD. Every dwelling shall be designed and constructed to support the actual dead load, live loads and wind loads acting upon it without exceeding the allowable stresses of the material. The construction of buildings and structures shall result in a system that provides a complete load path capable of transferring all loads from point of origin through the load-resisting elements to the foundation.

(a) Dead loads. Every dwelling shall be designed and constructed to support the actual weight of all components and materials. Earth-sheltered dwellings shall be designed and constructed to support the actual weight of all soil loads.

Dead Load of Insulation

To avoid ceiling drywall sag or related problems, attic insulation dead load should not exceed drywall manufacturer's recommended capacity. This is especially true today where heavy attic insulation and 24-inch truss spacing are common.

For example, one manufacturer, United States Gypsum, in its Gypsum Construction Handbook recommends that 3/8-inch drywall not be used to support insulation. They also specify that their other panel thickness may support insulation given the following load and framing spacing (drywall span) criteria:

Maximum Load	*Panel Thickness*	*Framing Spacing*
1.3 psf	*1/2 inch*	*24 inch o.c.*
2.2 psf	*1/2 inch*	*16 inch o.c.*
2.2 psf	*5/8 inch*	*24 inch o.c.*

Attic insulation materials vary in density and thermal properties. Therefore, the total weight per installed R-value will vary depending on type, installation method and manufacturer of insulation product. Some typical values are estimated below; check actual weights supplied from your manufacturer or installer.

Type	*Density*	*R/Thickness*	*R-38 Weight*	*R-50 Weight*
Cellulose	*2.4 pcf*	*3.6/inch*	*1.9 psf*	*2.8 psf*
Blown Mineral Wool	*1.2 pcf*	*2.8/inch*	*1.1 psf*	*1.8 psf*
Blown Fiberglass	*0.6 pcf*	*2.7/inch*	*.7 psf*	*1.0 psf*
Loose Fill Fiberglass	*1.1 pcf*	*2.5/inch*	*.7 psf*	*1.8 psf*
Fiberglas Batt R(19+19+13)	*0.7 pcf*	*3.2/inch*	*.6 psf*	*0.9 psf*

From the data above, most typical R-50 installations would exceed the capacity of 1/2-inch drywall on 24-inch o.c. framing unless the ½" drywall has been specifically designed for that purpose. However, 5/8-inch drywall on 24-inch framing (typical truss construction) would support most R-50 installations. Designers may want to check with the specific drywall manufacturer for span/load capacities when using 24-inch framing and high R-value cellulose installations. The above "USG" example indicates this may cause overloading.

(b) Live loads. 1. Floors and ceilings. Floors and ceilings shall be designed and constructed to support the minimum live loads listed in Table 21.02. The design load shall be applied uniformly over the component area.

TABLE 21.02

Component	Live Load (pounds per sq. ft.)
Floors	40
Garage floors	50
Exterior balconies, decks, porches	40
Ceilings (with storage)	20
Ceilings (without storage)	5

2. Snow loads. Roofs shall be designed and constructed to support the minimum snow loads listed on the zone map. The loads shall be assumed to act vertically over the roof area projected upon a horizontal plane.

Live Load - Snow

Exterior balconies or decks should be designed to withstand 40 PSF as the critical live load. Some designers have questioned if decks should be designed to withstand 70 PSF (40-occupant plus 30-snow). Such a design would be conservative, but not required.

The effect of drifting or sliding snow on a roof should be considered as a matter of good design practice. However, the UDC only requires a 30 or 40 PSF snow load applied uniformly to roofs. In complex roofs with side by side low-high portions or flat roofs below sloped upper roofs, a designer may want to consider potentially higher snow loads in the low roof areas where sliding or drifting snow may collect.

The UDC does not set lower snow live load values for roofs with glass or other slippery surfaces unless per s. Comm 21.27(1)(b), the slope is 7 in 12 or greater just as for other roof types. Otherwise, attached greenhouses, solar spaces, solar panels and other similar roof construction should be designed to withstand 40 or 30 PSF for zone 1 or 2 respectively.

(c) Wind loads. 1. Dwellings shall be designed and constructed to withstand a horizontal and uplift pressure of 20 pounds per square foot acting over the surface area.

2. Roof framing members spanning more than 6 feet measured from the outermost edge of the roof shall be permanently fastened to the top plate of load bearing walls using engineered clips, straps or hangers.

3. Roof framing members spanning 6 feet or less measured from the outermost edge of the roof shall be permanently fastened to the top plate of load bearing walls using toe-nailing, or engineered clips, straps or hangers.

Note: For information on toe-nailing, see the fastener schedule table in the appendix.

(d) Fasteners. All building components shall be fastened to withstand the dead load, live load and wind load.

Note: See the Appendix for a schedule of fasteners that will be acceptable to the department for compliance with this subsection. Other fastening methods may be allowed if engineered under s. Comm 21.02 (3).

Fasteners

Although the fastener schedule is part of the appendix and the code requires adequate fastening. The schedule presents one means of showing adequate fastening. Additionally, it may not be sufficient for certain designs.

Dwelling Anchorage

***Question**: When does a dwelling need to be anchored to the foundation?*
***Answer**: This section only discusses anchorage of the aboveground portion to the foundation. This is to prevent potential movement of the upper level due to wind pressure.*

Section 21.18 requires the top of the foundation wall to have adequate lateral bracing to the floor above, as through anchor bolts or other means. Where failures of foundations walls have occurred in the past, investigation has shown that many times damage could be attributed to lack of lateral support at the top of the walls rather than to faulty material or workmanship. In other cases, the use of a weak mortar in the masonry walls was an important contributing factor. The practice of some contractors backfilling basement walls before the first floor (lateral support system) is in place contribute to failures.

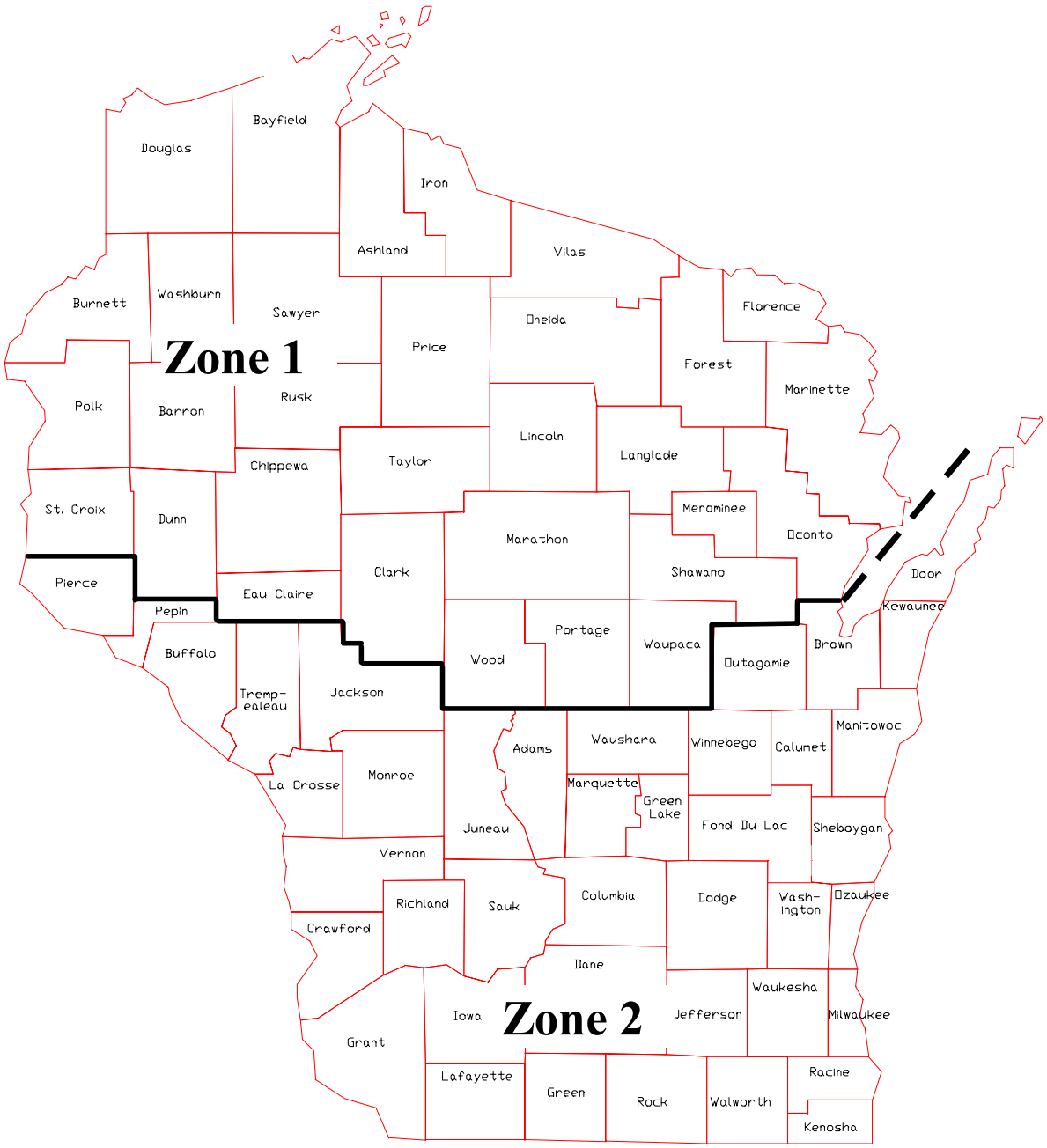
Section 21.22 (1m) also emphasizes that where sill plates are provided, the anchorage shall be continuous from the wall to the plate to the restraining floor system. This requires that solid bridging or blocking be installed between the rim joist and adjacent floor joist that run parallel to the foundation wall to transfer the loads on the wall.

Figure 21.02

ZONE MAP FOR ROOF LOADS

ROOF LIVE LOADS

Zone 1 - 40 PSF
Zone 2 - 30 PSF



(2) METHODS OF DESIGN. All dwellings shall be designed by the method of structural analysis or the method of accepted practice specified in each part of this code.

Note: See ch. NR 116, rules of the department of natural resources, for special requirements relating to buildings located in flood plain zones. Information regarding the elevation of the regional flood may be obtained from the local zoning official.

"Typical" Structural Analysis

Question: *A builder submits a building plan and includes "typical" structural calculations prepared and stamped by an architect or engineer. Is there any time limit placed on the acceptability of such "stamped" calculations?*

Answer: *Usually the typical calculations correspond to a master plan of a home built repetitively. When reviewing the building plans, you should verify that the loading conditions, spans, member sizes, member spacing and lumber grade as specified in the "typical" calculations are consistent with the plans. The use of such typical calculations or span tables (as in the Appendix to Ch. 21) is generally acceptable as long as the design criteria coincide with the building plans. There would be no time limit on the use of such calculations as long as they do not conflict with the requirements of the current code. An update of the calculations should be required if the code changes and different loads, load duration factors or other design criteria become effective.*

(3) STRUCTURAL ANALYSIS STANDARDS. Structural analysis shall conform to the following nationally recognized standards.

(a) Wood. 1. Except as provided in subpar a. and b., structural lumber, glue-laminated timber, timber pilings and fastenings shall be designed in accordance with the "National Design Specification for Wood Construction" and the "Design Values for Wood Construction," a supplement to the National Design Specification for Wood Construction.

a. Section 2.2.5.3. The cumulative effects of short-time loads, such as snow, shall be considered in determining duration of load. For snow load, no greater duration of load factor than 1.15 shall be used.

b. Section 4.1.7. The provisions of this section shall also apply to reused lumber. Reused lumber shall be considered to have a duration of load factor of 0.90.

2. Span tables for joists and rafters printed in the appendix or approved by the department may be used in lieu of designing by structural analysis.

(b) Structural steel. The design, fabrication and erection of structural steel for buildings shall conform to Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design and the provisions of the accompanying commentary as adopted under s. Comm 20.24 (3).

(c) Concrete. Plain, reinforced or prestressed concrete construction shall conform to the following standards:

1. ACI Std. 318, "Building Code Requirements for Reinforced Concrete."

2. ACI Standard 318.1, "Building Code Requirements for Structural Plain Concrete."

(d) Masonry. The design and construction of masonry shall conform to the provisions of the Concrete Masonry Handbook for Architects, Engineers, Builders as adopted under s. Comm 20.24 (15).

(e) Engineered structural components. Engineered structural components shall be used in accordance with structural analysis or with load tables supplied by the manufacturer, provided those load tables were developed using structural analysis or load testing.

Manufacturer's Recommendations

The Uniform Dwelling Code, s. Comm 21.02(2), requires that all dwellings be designed by the method of structural analysis or the method of accepted practice. It is accepted practice to install a material in a manner recommended by the material's manufacturer, if the installation is regulated by the code. A material installed in a manner that is inconsistent with the manufacturer's recommendation should not be allowed unless additional information is provided showing that the none recommended installation will still meet the performance requirement of the code. An example is listed equipment--if the equipment is not installed per manufacturer instructions, the listing is not applicable. A manufacturer's recommendation must also be checked for compliance with the Uniform Dwelling Code. It is the responsibility of the builder to have manufacturer's installation instructions available for review by the inspector (per s. Comm 20.09) when a question of proper installation arises.

Log Homes

The UDC does not have a specific code section on log home construction; however, log homes are often engineered and kit-produced by a manufacturer. In that case, their requirements should be followed. We have also adopted the log home construction standards in Comm 20.24. In the appendix of this commentary, we have reprinted one group's general guidelines for log homes that may be useful to you or you can download the entire adopted standards.

Roof and Floor Trusses

It is the responsibility of the inspector to verify conformance of the dwelling through the plan review process and the inspection process. It is recommended that builders or truss manufacturers demonstrate code conformance of their product to the building inspector in one of the two following manners:

1. *DIRECT APPROVAL* *In this situation, the builder provides the structural drawings and calculations for the truss or building component directly to the building inspector for the inspector's review. The code does not require that structural drawings or calculations be provided by a professional engineer or architect. The building inspector may review structural drawings and calculations for code compliance. Structural drawings and calculations are commonly sealed and signed by a professional engineer or architect and are generally considered as complying with the code.*

   All structural drawings and calculations shall conform to s. Comm 21.02(3) structural analysis standards.

2. *MATERIAL EVALUATION NUMBER* *Under this method, the manufacturer of the building component submits drawings and calculations to the Department of Commerce. The Department would review the drawings and calculations and issue an evaluation number to the manufacturer. The manufacturer provides the shop drawings with the appropriate evaluation number to the builder and/or inspector. These evaluation numbers will also be supplied independently to the inspection offices from the department by way of the Material Evaluation Notices. This will serve as a means of cross-referencing the numbers to the manufacturer and the trusses.*

   With this method, the building inspector has to rely on the shop drawing provided by the manufacturer to determine whether or not the product on the construction site conforms to the standards. The inspector would compare the shop drawing to the truss to verify that the same quality and size of lumber, connection plates, etc., were being provided as were approved on the shop drawing. The background structural calculations need not be repetitively submitted.

Engineering Terms Used in the Code or Referenced Standards

1. *ALLOWABLE STRESS (F)*
   - *Determined by physical testing of wood specimens of different grades and species.*
   - *Tabulated value already has a built in factor of safety.*
   - *Historically done by visual inspection of wood for defects (knots, checks.....) = Visual Graded.*
   - *Also can be done by machine by testing deflection-vs-load = Machine Stress Rated (MSR).*

2. *LATERAL SUPPORT*
   - *Structural bracing or interconnection that prevents movement of a structural member in a specific direction, usually perpendicular to the direction that the main structural member is providing support.*
   - *Examples:*
     - *bridging to joists*
     - *corner bracing to studs (let-in 1 x 4, metal straps, plywood panels)*
     - *subfloor to joists*
     - *sheathing to trusses*
     - *floor system to foundation walls*

- *basement floors to foundation walls*

3. *MODULUS OF ELASTICITY (E)*
   - *Ratio of stress/strain.*
   - *For a given force applied to a material, you can predict the deformation if you know E.*

4. *MOMENT*
   - *Force x distance (inch-lbs).*
   - *Causes curvature deformation in beams or columns.*
   - *Causes tension and compression stresses in beams and sometimes columns.*

5. *MOMENT OF INERTIA (I)*
   - *Used in the calculation of beam deflection.*
   - *Geometric property of a structural member.*
   - *$I = \frac{bd3}{12}$, inches4 (rectangular beam), b = width, d = depth*

6. *SECTION MODULUS (S)*
   - *Geometric property of a structural component (beam, column . . .).*
   - *S = M/Fb, inches3*
   - *$S = \frac{bd2}{6}$ (rectangular beam), b = width, d = depth*

7. *STRAIN*
   - *Deformation, (stretching, compaction, curvature) caused by an external force.*

8. *STRESS* - Internal resistance to an external force.*
   - Generally in lbs/in2 (psi).

- Fb = bending stress;
Resists curvature due to bending moment (Force).

- Fc,t = axial compression or tension stress;
Resists perpendicular compaction or stretching due to a longitudinal force.

- Fv = shear stress;
Resists slippage in plane of the surface parallel to the end face of the beam.

**Capitol (F) denotes "allowable" stresses in a material samples as determined by testing. Small case (f) denotes "actual" calculated stress of a structural member as based on design loads.*

Structural Analysis Standards - Wood

The following code-referenced standards shall be used in the design of roof and floor trusses.

The 2001 edition of the "NATIONAL DESIGN SPECIFICATIONS FOR WOOD CONSTRUCTION" and its supplement, "DESIGN VALUES FOR WOOD CONSTRUCTION," as published by the National Forest Products Association.

The "DESIGN SPECIFICATIONS FOR METAL PLATE CONNECTED WOOD TRUSSES" TPI-85 as published by the Truss Plate Institute, Inc.

The department has determined that the design minimum live load in Table 21.02 for ceilings with storage of 20 PSF applies to stick-built frame construction. Roof trusses designed in accordance with TPI-85 for attic storage loading will meet the intent of the code, only if such design criteria has been identified on the truss and drawings.

Outline of the National Design Specification (NDS)

This specification is adopted by the UDC s. Comm 20.24(2)(a) and s. Comm 21.02(3)(a). The NDS is used for structural design of wood members as an alternative or in addition to the prescriptive (accepted practice or "cookbook") standards in Ch. 21. It is the basis for the development of the Fastener and Span Tables in Appendix A-21 of the UDC. Its accompanying NDS Supplement provides allowable stress values depending on grade, species and dimensions of lumber used. It is also the basis for "Design Values For Joist And Rafters-Visual Grading" tables in Appendix A-21.

NDS Part I General Requirements for Structural Design

- *Includes guidelines for use of NDS considering the effects of:*
  - *Bracing*
  - *Connections at Joints*
  - *Adequate Load Assumptions*
  - *Most Conservative Load Combinations*

- *The NDS is intended to be adopted by governing codes such as the UDC which may prescribe the above minimum load and load combinations.*

NDS Part II Design Values

- *Allows for modification of design stresses due to:*
  - *moisture conditions*
  - *temperature*
  - *preservative treatment*
  - *fire retardant treatment*
- *Duration of load.*

Not all stress modifications are necessarily applicable to all beam and column installations.

Introduces the concept of a Load Duration Factor (LDF). The LDF will adjust allowable stresses, generally upward, to recognize that wood is more responsive in resisting short term loadings.

- *Floor Live Load = 1.0 (10 yr)*
- *Snow Load = 1.15 (2 mo.)*
- *Roof Live Load = 1.25 (7 day)*
- *Earthquake, Wind = 1.33 (1 day)*
- *Impact = 2.00 (2 sec)*

NDS Part III General Design Provisions and Formulas

1. *Beam Design*
   - *Formulas listed in text (also see s. 21.18(3) of this commentary).*
   - *Notching of beams - limitations similar to UDC.*
   - *In general, the NDS assumes rectangular sections (sawn lumber) are used. Certain modification factors can be used for other shaped (round) members. Also, other shaped members will have different geometric properties that will alter the "typical" formulas referenced in this commentary.*

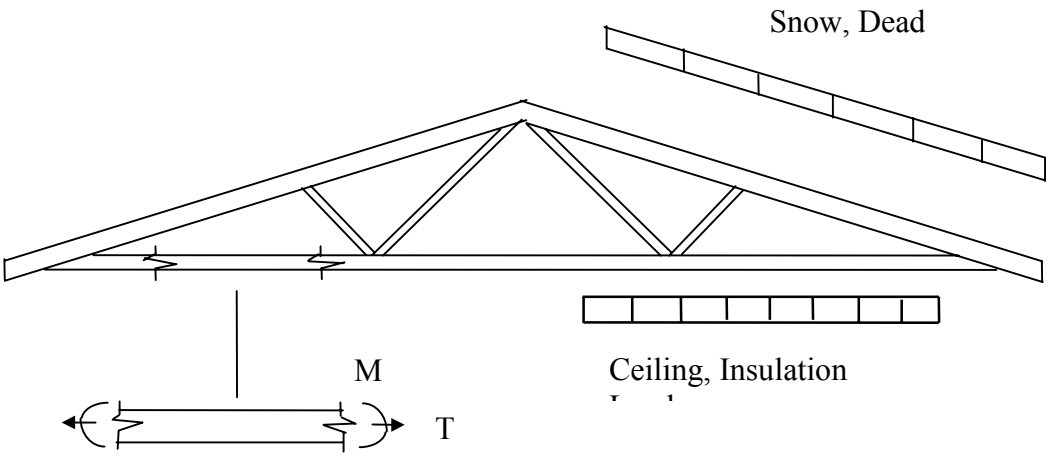
   - *Beam formulas can be complicated by and thereby adjusted to compensate for:*
     - *lack of lateral support*
     - *relatively long beam length*
     - *beam shape: round, rectangle, diamond*

   - *Beam design must also consider:*
     - *Shear stress (fv), especially for heavily loaded members.*
     - *Deflection considerations, especially for long spans or when the joist/beam depth is relatively small.*

2. *Column Design, Axial Compression (C)*
   - *Formulas listed in NDS.*
   - *Compression members can be horizontal or vertical (trusses).*
   - *Column design is a function of:*
     - *Area*
     - *Compressive Stress, fc*
     - *Column length, l*
     - *Column width, d*
     - *Shape: round, square, tapered*
     - *There is no one simple formula because of the many interrelated factors listed above.*

3. *Tension Members, Axial Tension (T)*
   - *Formulas listed in NDS.*
   - *Member design is a function of:*
     - *Area*
     - *Tensile stress, ft.*
     - *Usually end connections are most critical in design.*

4. *Combined Axial (T or C) & Bending Stress*
   - *Common in truss design and pole buildings.*



Member
Stresses: Axial Tension and
Bending Moment

- *Formulas listed*
- *Simplest case:*

fb + ft(c)
Fb Ft(c) less than or equal to 1.0

f = actual member stress
F = allowable member stress

- *This means that the sum of the percentage of actual bending tension (or compression) stress plus the percentage of actual axial tension (or compression) stress should be less than 100 percent of allowable tension (or compression) stress. That is, allowable stress equals the sum of the contributions from bending plus axial allowable stresses.*

NDS Part IV Sawn Lumber

- *Refers to design values given in NDS Supplement. Allowable stresses differ depending on single-vs-repetitive member use.*

- *Single member use*
  - *individual member responsible for carrying entire load*
  - *example: beam, column*
  - *no "near neighbors" to share load*

- *Repetitive member use*

- *bending members only*
- *spaced 24 in. o.c. or less*
- *not less that 3 in number*
- *joined by floor or roof decking to spread load to adjoining members*
- *example: joists, rafters, trusses, built up beams*

NDS Part V Structural Glued Laminated Timber

(Also see further information in this commentary section.)

- *General Design Values based on visual and machine stress rated methods given in Tables 5A, 5B and 5C of the NDS Supplement.*

- *Design values can be modified due to service condition, etc., similar to those specified in Part II.*

- *Curved glued laminated members (arches) are possible and special consideration is specified.*

- *Glued laminated members subject to compression or combined tension-compression are designed per Part III with some additional requirements.*

NDS Part VI Round Timber Piles

- *Rarely used for UDC construction.*

- *Specifies types of preservative treatment, typical dimensional requirements per American Wood Preservers Association (AWPA) and ASTM standards.*

- *Design values and modification factors based on service condition, size and condition of preservative treatment.*

NDS Part VII Structural Assemblies

- *References American Panel Association (APA) documents, "Plywood Design Specification" and "Diaphragms" for design and construction recommendations of structural assemblies consisting of panel products.*

NDS Part VIII Wood Fastenings

- *Tables give design values, load per fastener, for:*
  - *nails (common, box, etc., with minimum diameters)*
  - *screws (lag, wood)*
  - *bolts*
  - *split rings*
  - *metal plates*
- *This information is used to develop the fastener table in UDC Appendix.*

NDS Supplement: Design Values

- *Depending upon species, grade, and size classification, design values are provided for various loading situations:*

  Fb - Allowable bending stress, psi
  Fc - Allowable compressive stress (parallel to grain), psi
  Fcl- Allowable compressive stress (perpendicular to grain), psi
  Ft - Allowable tension stress, psi
  Fv - Allowable shear stress, psi
  E - Modulus of Elasticity, psi

- *Some values also reprinted here based on the 1991 NDS.*

Note: See Appendix for complete tables for all species and values.

Overview Of Important Issues Regarding Trusses

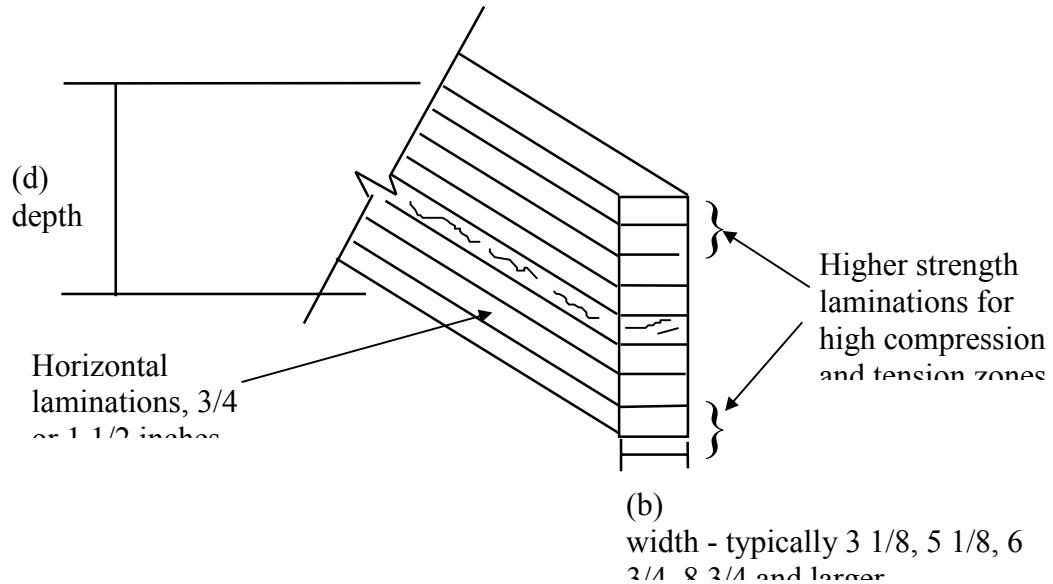
1. *Per s. Comm 21.02(3), Note #1*
   Trusses should conform to TPI-85, "Design Specification For Metal Plate Connected Wood Trusses."

2. *Per s. Comm 20.09(4)(a)*
   The designer may be required to submit plans showing the truss design is consistent with or shows:
   - *house framing plan*
   - *bearing and connection/anchorage details*
   - *design loads*
     - *top and bottom chord load*
     - *live, dead, wind load*
     - *concentrated or nonuniform loads*
   - *outside configuration of components*
   - *permanent bracing system if required*
   - *connector plate size per joint*

3. *Per s. Comm 20.09(4)(b)*
   The designer may be required to submit data including:
   - *stress calculations*
     - *axial*
     - *bending*
     - *combined*
   - *species, grade, size of members*
   - *member forces*
   - *reactions*
   - *connector plate capacity required per joint*

Additional Background Information Glue Laminated Timber[1]

1. *Used for long spans, large loads and architectural effect.*
2. *Relatively thin laminations of wood combined to practically any length and size.*



3. *Relatively higher structural properties.*
   - *Laminations of high quality wood*
   - *Defects - Knots etc., spread out, not continuous for depth or width of member*
   - *Maximum 2600 psi bending stress = F_b, compared to 1900 psi for sawn lumber*

4. *Glue generally for wet use applications with some dry use glue allowed, but not common.*

5. *Graded differently than sawn lumber.*

   - *24F indicates allowable bending stress = 2400 psi under normal conditions.*
   - *V1, V2 etc., refers to Visual Graded No. 1 or 2.*
   - *E1, E2 refers to Machine Grading by testing the Modulus of Elasticity.*

6. *Some condition of use and load duration adjustment factors may apply.*

7. *Design properties are included in the NDS Supplement.*

(1) Source: Breyer, Donald E., Design of Wood Structures, Mc Graw Hill, 1980.

<u>Used and Ungraded Lumber</u>

1. *<u>Used Graded Lumber</u>*

Sound used lumber with grade marks still identifiable may be used for one- and two-family dwellings as follows:

(1) The published NDS allowable design stresses for the lumber species and grade represent values for new lumber. To apply to used lumber, these must be reduced to a 90 percent value. NOTE: For joists and rafters, use "F_b" for

repetitive-member use under normal duration load conditions. These used, 90 percent reduced bending values should not be increased using LDF's for snow or construction loading conditions.

(2) The span tables for joist and rafters in the appendix of the code may be used with the reduced design stresses.

2. Used Ungraded Lumber and Used Resawn Graded Lumber

Sound used non graded and sound used re-sawn graded lumber may be used for one- and two-family dwellings using method (1a) or (1b) below to determine allowable design stresses at 19 percent moisture content.

(1a) The used non graded or used re-sawn graded lumber must be graded based on the re-sawn and certified in accordance with nationally recognized lumber grading rules for visually graded lumber per ASTM D245. Agencies publishing grading rules are listed in the NDS "Design Values for Wood Construction."

(1b) Alternative Method - Use the NDS published allowable design stresses for lumber species using No. 3 or utility grades for studs, rafters and joist and No. 1 grade for beams, stringers, post and timbers in lieu of certified graded or re-graded lumber.

(2) The published NDS allowable design stresses for the lumber species and grade for certified graded lumber or the No. 3, utility and No. 1 grades must be reduced to a 90 percent value. NOTE: For joist and rafters use "Fb" for repetitive-member use under normal duration load conditions. These reduced bending values should not be increased using LDF's for snow or construction loading conditions.

(3) The span tables for joist and rafters in the appendix of the code may be used with the reduced design stresses.

3. Native Sawn Ungraded Lumber

Sound native sawn un-graded lumber may be used for one- and two-family dwellings using method (1a) or (1b) below to determine allowable design stresses at 19 percent moisture content.

(1a) The native sawn lumber must be graded and certified in accordance with nationally recognized lumber grading rules for visually graded lumber per ASTM D245. Agencies publishing grading rules are listed in the NDS "Design Values for Wood Construction."

(1b) Alternative Method - Use the NDS published allowable design stresses for the lumber species using No. 3 or utility grade for studs, rafters, and joist and No. 1 grade for beams, stringers, post and timbers in lieu of certified graded lumbers.

(2) The span tables for joist and rafters in the appendix of the code may be used with the allowable design stresses for graded or No. 3 utility and No. 1 grade lumber. NOTE: For joist and rafters use "Fb" for repetitive-member use and for beams, stringers and timbers use "Fb" for single-member use. These allowable bending values may be increased using LDF's of 15 percent for snow or 25 percent for construction loading conditions in accordance with NDS.

(3) For lumber species not listed in the NDS "Design Values for Wood Construction" and where nationally recognized allowable design stresses are not available, structural testing of the materials will be required. Testing must be conducted by a recognized independent testing agency in accordance with the appropriate ASTM load test procedure. The cost of such testing shall be borne by the person applying for the building permit.

The department will accept lumber species design stresses recommended by the U.S. Forest Products Laboratory, Madison, Wisconsin.

4. <u>References and Definitions</u>

A. NDS - The "National Design Specification for Wood Construction" (NDS) and its supplement "Design Values for Wood Construction" 1997 editions as published by National Forest Products Association. Comm 20.24(2)(a).

B. <u>Sound lumber</u> is defined as materials without structural damage such as splits, cracks, gouges, saw , rot or insect damage and with notching and borings limited as follows:

- *Notching and boring of members shall be limited to that permitted in Ch. Comm 21 for floor, wall, ceiling and roof members.*

  (1) Beams, girders and joists - s. Comm 21.22(5)
  (2) Columns, posts and studs - s. Comm 21.25(4)
  (3) Rafters and ceiling joists - s. Comm 21.28(6)

C. <u>Unsound framing (structural) lumber</u> shall not be used in one- and two-family dwellings.

<u>T-30 and T-50 Lumber</u>

It has been brought to our attention that lumber products using the designations of T-30 and T-50 are being used in Wisconsin. These 2" x 4" spruce-pine-fir lumber products designated by Weyerhaeuser as T-30 and T-50 are taken from machine stress rated stock graded 1450-1.3E and 1800-1.6E, respectively. These new designations are intended to take advantage of better than average lumber within the stress grade level as well as more accurate stress grading procedures and equipment.

The following allowable stresses (in PSI) associated with these products are approved for use in Wisconsin.

Grade	*F_b*	*F_t*	*F_c*	*MOE*
T-30	*1450*	*800*	*1150*	*l,300,000*
T-50	*1800*	*1175*	*1450*	*l,600,000*

Any design values differing from the above are not to be accepted without complete test data from an approved testing lab wherein ASTM procedures are followed.

These products do not require a material approval as this is not a new construction material or new assembly.

Comm 21.03 Exits, doors and hallways.

Exits, doors and hallways shall be constructed as specified in this section.

(1) EXITS FROM THE FIRST FLOOR. (a) Except as allowed under par. (h), every dwelling unit shall be provided with at least 2 exit doors accessible from the first floor.

(b) At least one of the exits shall discharge to grade. This exit may include interior or exterior stairs.

(c) An additional exit may discharge to an outside balcony that complies with sub. (10).

(d) An additional exit may discharge into an attached garage provided the garage has an exit door that discharges to grade. An overhead garage door may not be used as an exit door.

(e) Except as allowed under pars. (f) and (h), the 2 required exit doors shall be separated by at least the greater of the following distances:

1. One-third the length of the longest diagonal of the floor in plan view, exclusive of an attached garage.

2. 20 feet.

Note: See appendix for examples of exit separation design.

(f) 1. First floor levels that do not meet the separation requirements under par. (e), shall have at least one egress window complying with sub. (6) on that floor level.

2. An egress window to comply with subd. 1. shall be separated from at least one door on the first floor by one of the distances under par. (e).

3. If first floor levels that do not meet the separation requirements under par. (e) contain one or more sleeping rooms, each sleeping room shall have at least one egress window complying with sub. (6).

(g) 1. The exit separation distance required under par. (e) shall be calculated or measured as a straight line from the midpoint of one doorway to the midpoint of the other doorway.

2. For exiting through an attached garage, the separation distance shall be measured using the door connecting the garage and the dwelling. Distance within the garage shall be ignored.

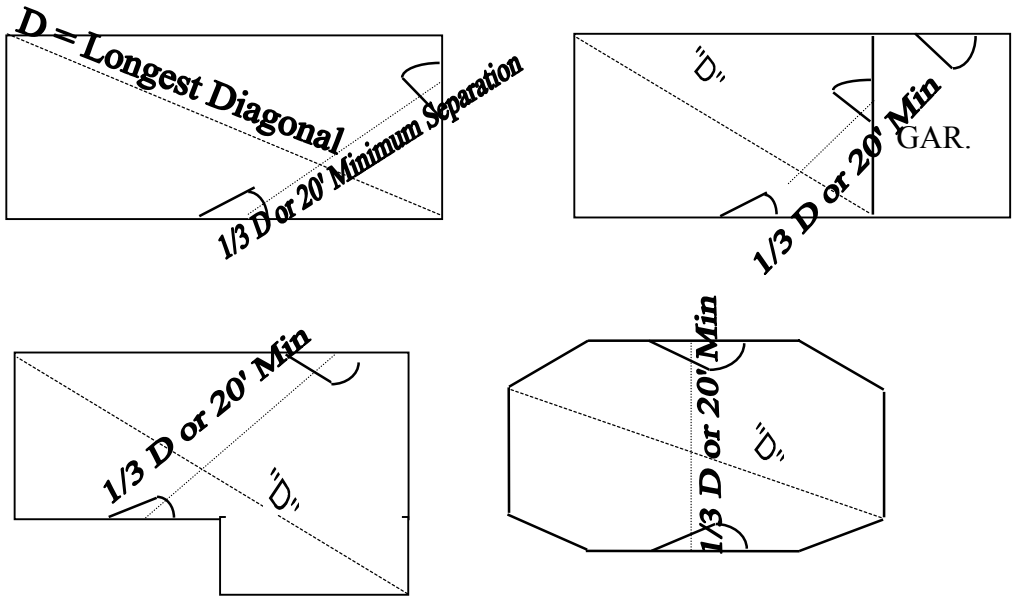
(h) 1. Dwellings consisting of no more than a first floor with a maximum floor area of 250 square feet and a loft area not exceeding half of the first floor area, shall be provided with at least one exit door leading directly to the exterior and at least one egress window that complies with sub. (6).

2. a. Dwellings that meet the size restrictions under subd. 1., are not required to meet the exit separation requirements under subs. (e) or (f).

b. If a dwelling that meets the size restrictions under subd. 1., has more than one room on the first floor, the door and the egress window shall be located in different rooms.

Separation of Exits

Note that these sections require the two required exits to be separated a distance of at least one-third the longest diagonal measurement in plan view of that floor or at least 20 feet (see diagrams).



ss. Comm 21.03(1), (e) 1., & (e) 2.
SEPARATION OF EXITS

Acceptable First Floor Exits

Question: *Is it acceptable to use a ground floor exit door to help satisfy the requirement for two exits from a first floor?*

Answer: *Yes, assuming the two floors are connected with a stairway and the other requirements are met.*

Earth-Sheltered Dwellings

Per the definition of first floor in s. Comm 20.07(34e), there is always a first floor, so a single-story (first floor) earth sheltered dwelling requires two exits per this section. Egress windows may not be used to satisfy requirement. See sections 20.07(34e) and 20.10(1)(b)4.a. of this commentary for further discussion.

Question: *Are first floor bedrooms required to have egress windows?*

Answer: *No. The code indicates two exits are required from the first floor; however, if the exit separation requirements are not met then any first floor bedroom would require egress windows. The code further allows the use of egress windows in lieu of the second exit requirement from second floor* ***or*** *basement.*

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Bedroom Exit Windows

Question: *Can egress windows be located in sitting or dressing areas of a master bedroom suite?*

Answer: *This section requires egress windows in some bedrooms. However, it does not specify location of the window within the bedroom itself. A sitting room or area located in an alcove of a master bedroom is an acceptable location for the bedroom egress window. The alcove can be considered part of the bedroom if there are no doors obstructing communication between the two areas.*

(2) EXITS FROM THE SECOND FLOOR. (a) At least 2 exits shall be provided from the second floor. One of the exits shall be a stairway or ramp and lead to the first floor or discharge to grade. The second exit may be via a stairway or ramp which discharges to grade or may discharge to a balcony which complies with sub. (10).

(b) Except as provided in par. (c), windows which comply with sub. (6) may be provided in each second floor bedroom in lieu of the second exit from the floor.

Question: *If one of the second floor bedrooms has a code-compliant exit door out of the bedroom onto a deck or balcony, can the requirement for egress windows in the other bedrooms be waived?*

Answer: *Yes, but only if the hardware on the bedroom door, which leads to the second exit is incapable of being locked from the hallway that serves as the exit path from these other bedrooms .See chapter 20.07 for 'EXIT' definition.*

(c) Where the second floor is the lowest floor level in a dwelling unit, as in an up-and-down duplex, windows may not be provided as the second exit from the floor.

(3) EXITS ABOVE THE SECOND FLOOR. At least 2 exits shall be provided for each habitable floor above the second floor. The exits shall be located such that in case any exit is blocked some other exit will still be accessible to the second floor. The exits shall be stairways or ramps that lead to the second floor or discharge to grade.

Acceptable Exits Above the Second Floor

Only stairways or ramps to the second floor or grade are acceptable to meet the two exit requirements. If the bottom of this stairway terminates at the second floor there must be a door leading back into the dwelling to complete the exit path. The stairway may not discharge onto a roof at the second floor level without a level landing and egress into the second floor. Egress windows or a balcony may not be used.

Exits from Attics

***Question**: Does the requirement for two exits for floors above the second floor apply to walk-up attics?*

***Answer**: No - it would only apply to habitable spaces including offices, playrooms or other conditioned spaces (see Comm 22.06(5)) that may be occupied. Since attics are not considered habitable spaces they need not have natural light and ventilation nor multiple electrical outlets or lights unless they are used for mechanical equipment or electrical equipment.*

(4) EXITS FROM LOFTS. (a) At least one stairway exit shall be provided, to the floor below, for a loft exceeding 400 square feet in area.

(b) At least one stairway or ladder exit shall be provided to the floor below for a loft, 400 square feet or less, in area.

Exits from Lofts

A code-complying loft is not subject to the exiting requirements of the other subsections of this section. In other words, a loft open to a first-floor below, only requires a single stairway or ladder (depending on area) to satisfy exiting. A loft bedroom or loft level would not require an egress window but would require natural light and ventilation the same as any other habitable space. See s. Comm 20.07(50) of the code and this commentary for a discussion of what is considered "open to the floor below."

(5) EXITS FROM BASEMENTS AND GROUND FLOORS. (a) General. Except as provided in par (b), all basements and ground floors shall be provided with at least one exit of the following types:

1. A door to the exterior of the dwelling.

2. A stairway or ramp that leads to the floor above.

(b) Basements and ground floors used for sleeping. 1. Basements and ground floors used for sleeping shall be provided with at least 2 exits.

2. The exits shall be located as far apart as practical.

3. The exits may not be accessed from the same ramp or stairway.

4. In addition to the exit type required under par. (a), the second exit from a basement or ground floor used for sleeping shall be one of the following types:

a. A door to the exterior of the dwelling.

b. A stairway or ramp that leads to the floor above.

c. A stairway that leads to a garage provided the garage has an exit door other than the overhead door.

d. An egress window that complies with sub. (6), located in each bedroom.

(6) WINDOWS USED FOR EXITING. Windows which are installed for exit purposes shall comply with the requirements of this subsection.

(a) The window shall be openable from the inside without the use of tools or the removal of a sash. If equipped with a storm or screen, it shall be openable from the inside.

(b) 1. The nominal size of the net clear window opening shall be at least 20 inches by 24 inches irrespective of height or width. Nominal dimensions shall be determined by rounding up fractions of inches if they are 1/2-inch or greater or rounding down fractions of inches if they are less than 1/2-inch.

2. No portion of the window, including stops, stools, meeting rails and operator arms, shall infringe on the required opening.

(c) The area and dimension requirements of par. (b) may be infringed on by a storm window.

(d) 1. For any window used for exiting, the lowest point of clear opening shall be no more than 60 inches above the floor.

2. If the lowest point of clear opening is more than 46 inches above the floor, a permanent platform or fixture shall be installed such that a flat surface at least 20 inches wide and 9 inches deep is located no more than 46 inches directly below the clear opening.

3. The topmost surface of the platform or fixture shall be no more than 24 inches above the floor.

4. The topmost surface of the platform or fixture shall support a live load of at least 200 pounds.

5. A step used for the sole purpose of reaching the top of the platform or fixture is exempt from the requirements of s. Comm 21.04.

(e) 1. An egress window with any point of clear opening below adjacent grade shall be provided with an areaway in accordance with this section.

2. The width of the areaway shall be at least equal to the width of the window.

3. The areaway shall be a minimum of 36 inches measured perpendicular from the outer surface of the below-grade wall.

4. If the bottom of the areaway is more than 46 inches below adjacent grade or the top of the areaway enclosure, the areaway shall be provided with a ladder or at least one additional step to aid egress. Steps used to comply with this section are exempt from the requirements of s. Comm 21.04.

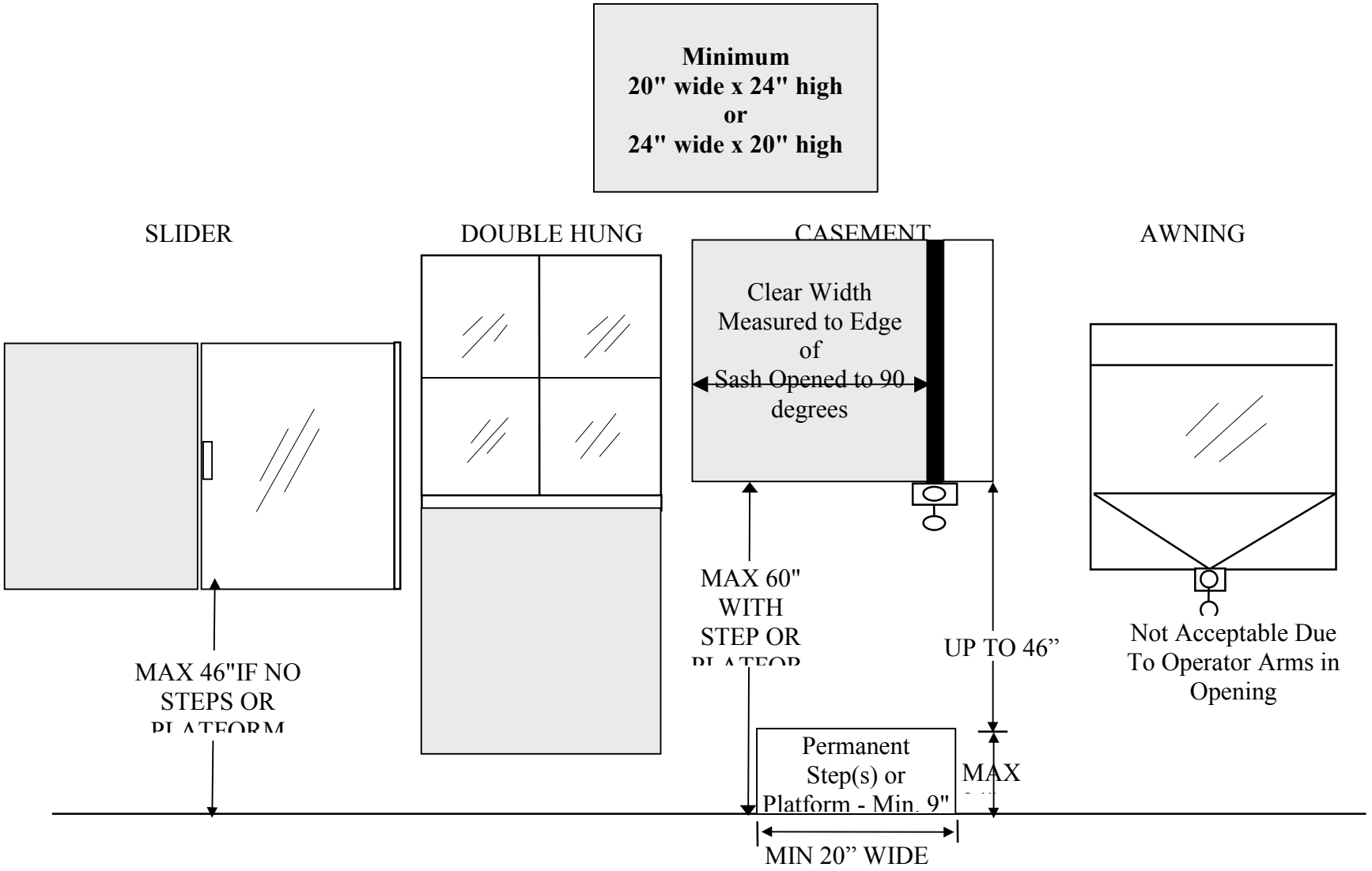
5. Ladders or other steps used to comply with subd. 4. may infringe on the required area of the areaway by a maximum of 6 inches.

6. The areaway shall be constructed such that water entering the areaway does not enter the dwelling.

Question: *Are there State-approved manufactured areaways that meet the UDC code requirements or are equivalent?*

Answer: *Yes, to date, two manufacturers have applied for and been granted approvals for egress window areaways that meet the intent of the code. Some of these have "ledges or stepped terraces" that do not meet Comm 21.04 for stairs, but act as an aid to exiting. They have been granted even when the wall furthest away from the house (which may have stepped ledges in it) do not measure 36" out from the house.*

Comm 21.03 (6)
Egress Window Dimensions



Exit Windows
See following diagram.

(7) DOORS USED FOR EXITING. Doors used for exiting shall comply with the following requirements:

(a) One of the exit doors from a dwelling unit shall be a swing-type door at least 36 inches wide by 80 inches high.

(b) 1. Except as allowed under subd. 2., all other required exit doors shall be at least 32 inches wide by 76 inches high.

2. Sliding patio doors used as a required exit shall have a clear opening of at least 30 inches.

(c) Where double doors are used as a required exit, each door leaf shall be at least 30 inches wide and the doors may not have an intermediate mullion.

(d) All exit doors shall be openable from the interior without the use of a key.

Minimum Door Width

Question: *When these sections refer to a minimum door width of 2'-8", how is to be measured.*
Answer: *The door itself should be measured - not the distance between jambs or stops.*

(8) INTERIOR CIRCULATION. All doors or openings to the following areas shall be at least 80 inches high and either provide a minimum net clear opening width of 30 inches or be a 32-inch door:

(a) At least 50% of the bedrooms.

(b) All common use areas including kitchens, dining rooms, living rooms, family rooms, basements and garages.

(c) At least one full bathroom, including doors or openings to the sink, toilet and tub or shower.

Interior Circulation - Accessibility

Question: *Can a "half-bath" with a 2'-8" door be considered accessible to disabled persons.*
Answer: *No. The code is clear in requiring one full bathroom be provided with a 2'-8" wide door. A full bathroom would contain a lavatory, water closet and bathtub or shower.*

Question: *What use is an "accessible" bathroom or bedroom with a 2'-8" door when it is on the second floor?*

Answer: *The intent of this section is to minimize future structural door framing alterations necessary to make a dwelling accessible to a physically handicapped resident. Obviously, further alterations would be necessary for the second floor situation, such as a stairway chair-lift or platform lift. Also, there may be temporary situations where a handicapped resident or guest, with physical assistance, could still make use of these second story rooms. "Accessible" does not always mean wheelchair accessible.*

Question: *Can a 2'-6" flush opening pocket door be considered accessible?*
Answer: *This section requires, where cased or uncased openings are provided in lieu of doors, the clear width of passageway openings shall be at least 2'-6" wide. Where a pocket door is installed into a cased opening, the 2'-6" width requirement still applies. In this situation, the pocket door could* ***not*** *be provided with any doorstops and must open at least flush with the cased opening so that neither the door or trim infringe upon the cased opening width.*

The intent of this code section is to provide a minimum 2'-6" width for disabled person use. Alternatively, a 2'-8" wide opening is required when swing doors are installed because of the door stops and door itself infringe on the opening width such that the effective opening is 2'-6".

Question: *Are interior doors required to separate rooms such as bedrooms or bathrooms from the rest of the dwelling?*
Answer: *No, although it is common practice to have door separating these areas, doors are not required. The minimum opening requirements in Comm 21.03 (8) must be met but doors or privacy hardware is not a code requirement.*

(9) HALLWAYS. Hallways shall be at least 3 feet in width except that door hardware, finish trim and heating registers may infringe upon this dimension.

(10) BALCONIES. (a) Balconies shall be made of concrete, metal or wood which is treated, protected or naturally decay-resistive in accordance with s. Comm 21.10.

(b) Balconies shall be provided with guardrails in accordance with s. Comm 21.04 (3).

(c) Balconies which are required for exit purposes shall also comply with all of the following requirements:

1. The balcony guardrail shall terminate no more than 46 inches above the floor level of the balcony.

2. The floor level of the balcony shall be no more than 15 feet above the grade below.

3. The floor of the balcony shall have minimum dimensions of 3 feet by 3 feet. The guardrail and its supports may infringe on the dimensions of the required area.

Balconies

*Balconies **not** used for a required exit purposes may be greater than 15 feet above grade. Guardrails for balconies are required to comply with Comm 21.04(3) regarding height, in-fill or spindle and rail spacing requirements.*

(11) SPLIT LEVEL DWELLINGS. In determining the exit requirement in a split level dwelling, all levels that are to be considered a single story shall be within 5 feet of each other.

Split Level Dwellings

This section allows floor levels within 5 feet vertically of each other to be considered one floor level for exiting purposes. This does not change the definitions of the floor levels as set forth in s. Comm 20.07. Also the requirements of ss. Comm 21.03(1), 21.03(5)(b), and 21.03(6)(b) for proper separation of exits apply to the combined areas of the floor levels..

*Also, any combined floor levels must all be within 5 feet of each other. In other words, a floor level that is between two other floor levels, separated by more than 5 feet, does not make all three levels into one even if exiting is from the middle level. However, the middle level may be combined with **only one** of the other levels.*

(12) TWO-FAMILY DWELLINGS. In a 2-family dwelling, each dwelling unit shall be provided with exits in compliance with this section.

Comm 21.04 Stairways and elevated areas.

(1) SCOPE. Every interior and exterior stairway, including tub access steps but excluding non-required basement stairways which lead directly to the building exterior and stairways leading to attics or crawl spaces, shall conform to the requirements of this section.

Non-required Stairs

Although stairways to attics and crawlspaces are not covered by the code, other non-required stairs, such as a second stairway from the first floor to a basement, are covered. Stairways are a major location of deaths and serious injuries in the home. Statistics from the U.S. Consumer Product Safety Commission (CPSC) show that one in four people will be injured and seek hospital treatment due to an injury related to stairways sometime in their lives. In 1994, the number of injuries from stairs, ramps, landings and floors was 1,879,029. This was an increase over the previous year by 11 percent (200,000-plus injuries), and was roughly equivalent to 19 percent of the total number of injuries reported in all categories for that same year.

The CPSC also estimates that the cost of home injuries in 1994 was $94.3 billion. The cost directly related to injuries from stairs, ramps, landing and floors was $17.5 billion.

Similarly, a study prepared for the U.S. National Bureau of Standards estimated that stair riser/tread dimensions are factors in nearly 50 percent of all stair-related injuries in the home.

Exterior Stairs

***Question**: This section applies to exterior stairs but how far away from the dwelling would this coverage extend?*

***Answer**: The stair requirements would apply to any steps necessary to get an occupant free and clear of the dwelling and to grade.*

***Question**: Do bulkhead-type doors and stairways need to be code complying?*

***Answer**: No, they must be code complying only if they are used AS AN EXIT, not if they are used as a service or non-required stairway. Verify the following item for required exits:*

- landings,
- handrails,
- stairway width,
- headroom, and
- stair treads and risers.

In the case of bulkhead-type doors and stairs:

- *The headroom height may be measured with the doors open, since the stairway is only usable if the doors are opened; and*

- *A landing is not required at the head of the stairway since this is considered an interior stairway protected from the weather. However, a landing is required at grade outside the door.*

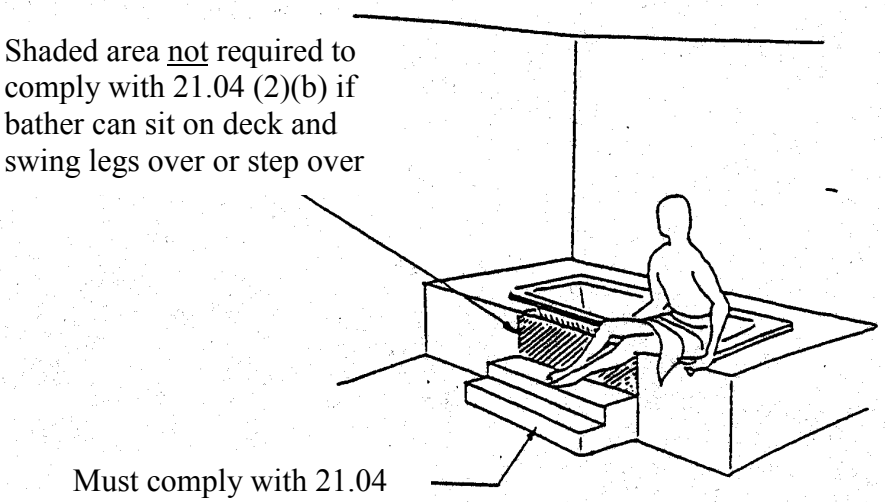
Regarding the door(s), they must meet the exit door requirements if this is a required exit. That means it must be 2'-8" wide if there is a single door and 2'-6" each if there are double doors. If this is not a required exit, then no minimum width applies. Door headroom, at the bottom of stairs, would normally have to be in compliance with the required stairway headroom.

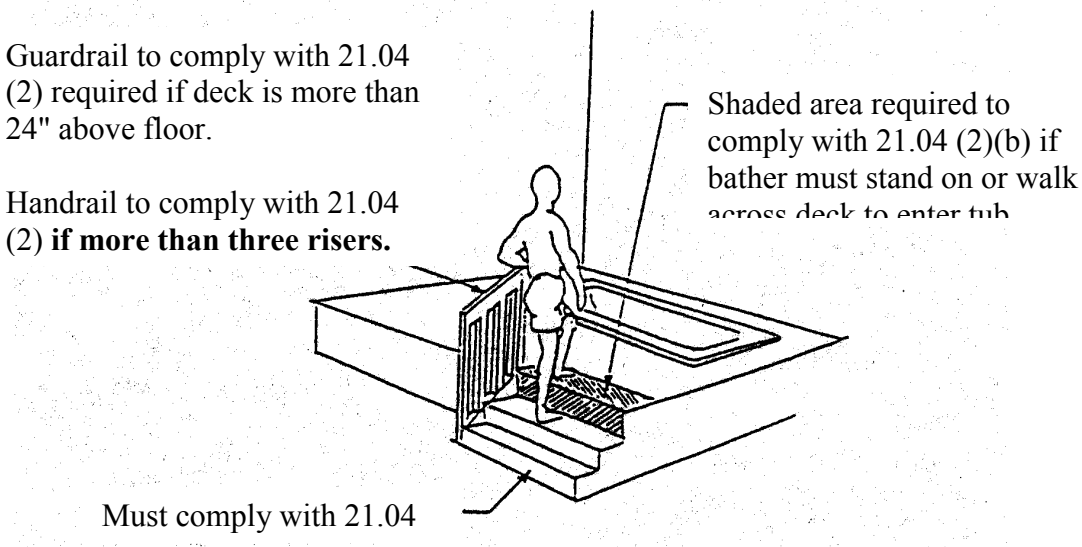
***Question**: Is a door required between the bottom of a bulkhead-type stair and the basement that it serves?*

***Answer**: This section of the code is silent on this; however, under Comm 22, most likely a door would be needed to meet the energy requirements.*

Bathtub Platforms

Question: *Do the stair code requirements apply to steps serving a bathtub platform?*
Answer: *Yes. Where a step or steps are provided at a bathtub, whirlpool or hot tub, the steps are required to have a minimum 9-inch tread and maximum 8-inch riser. Where more than one step is provided, the steps need uniform risers and treads. The rim of the tub should not be considered a step unless it is a large area where occupants are likely to walk around the tub. Steps are not required to be provided at the base of a tub, but due to damp slippery conditions associated with tubs, steps that are provided should comply with the code.*





Headroom Width and Handrail requirements of Comm 21.04. (See following diagram.)

(2) DETAILS. (a) Width. 1. Except for spiral staircases under subd. 2., stairways shall measure at least 36 inches in width. Handrails and associated trim may project a maximum of 4.5 inches into the required width at each side of the stairway.

2. Spiral staircases shall be at least 26 inches wide measured from the outer edge of the supporting column to the inner edge of the handrail.

(b) Riser height. 1. a. Except for spiral staircases under subd. 2., risers may not exceed 8 inches in height measured vertically from tread to tread.

b. At the top and bottom of a flight, measurement shall be taken from the top of the nosing to the finished floor surface unless the finished surface is carpeting, in which case measurement shall be made to the hard surface below the carpeting.

2. Risers in spiral staircases may not exceed 9.5 inches in height measured vertically from tread to tread.

(c) Tread depth. 1. 'Rectangular treads.' Rectangular treads shall have minimum tread depth of 9 inches measured horizontally from nosing to nosing.

2. 'Spiral staircase treads.' Spiral staircase treads shall have a minimum tread depth of 7 inches from nosing to nosing measured at a point 12 inches from the narrow end of the tread.

3. 'Winder treads in series.' Two or more winder treads may be placed immediately adjacent to each other anywhere in a stairway provided both of the following conditions are met:

a. The winder treads shall have a minimum tread depth of 7 inches measured at a point 12 inches from the narrow end of the tread.

b. The depth of the immediately adjoining winder treads shall be equal at a point 12 inches from the narrow end.

4. 'Individual winder treads.' a. An individual winder tread may be placed between rectangular treads or at the end of a flight of rectangular treads provided the tread depth, measured at a point 12 inches from the narrow end, is equal to the tread depth of the rectangular steps in the flight.

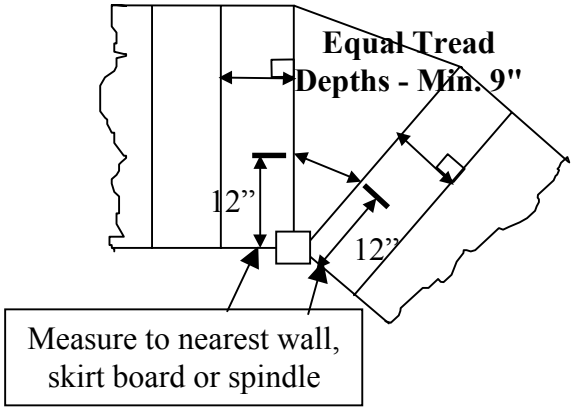
b. There may be more than one individual winder tread in a stairway or in a flight of stairs.

(d) Headroom. 1. Stairways shall be provided with a minimum headroom clearance of 76 inches measured vertically from a line parallel to the nosing of the treads to the ceiling, soffit or any overhead obstruction directly above that line.

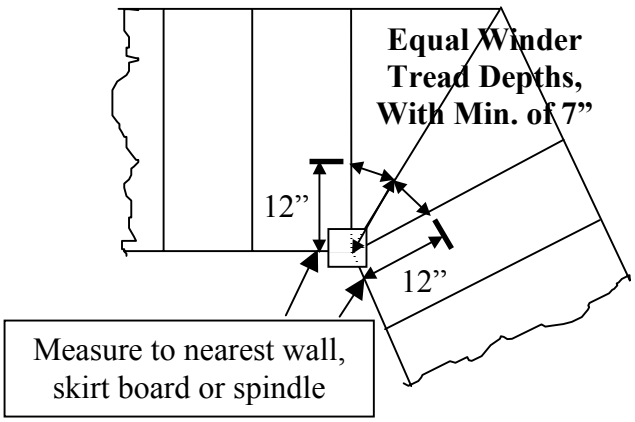
2. The headroom clearance shall be maintained over an intermediate landing.

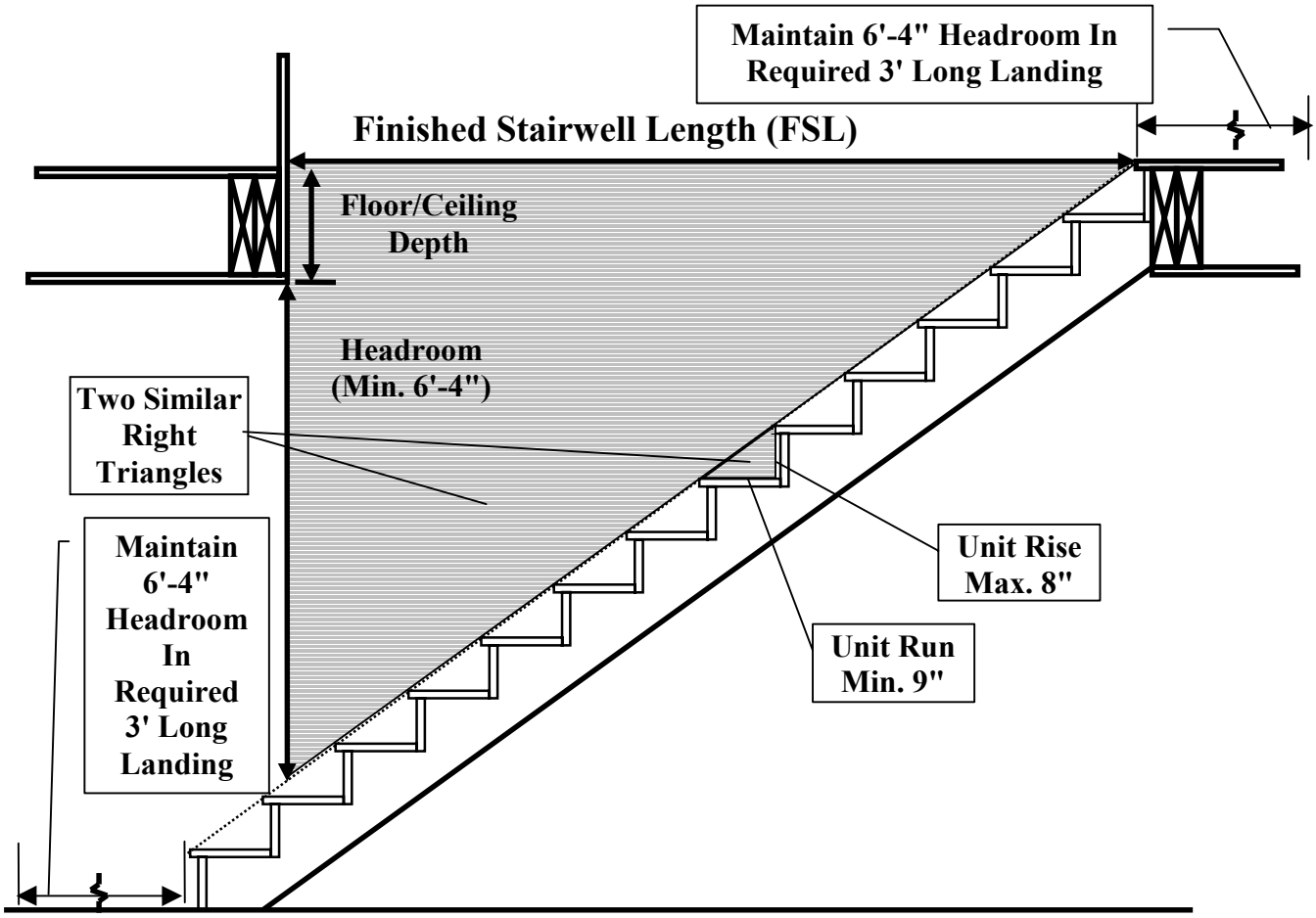
Commentary

SINGLE WINDER



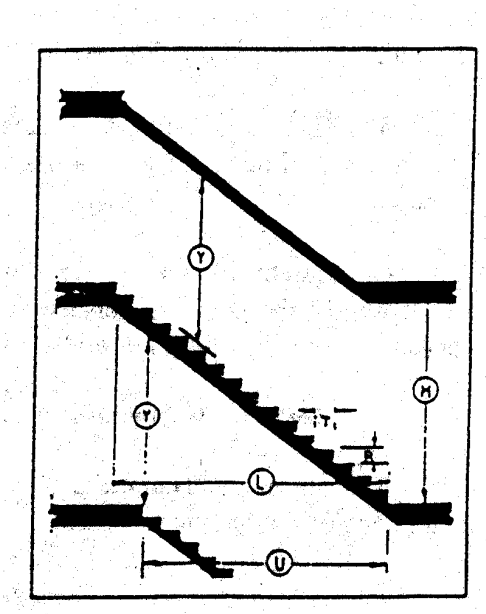
MULTIPLE WINDERS





$$\frac{\text{Headroom + Floor/Ceiling Depth (HFCD)}}{\text{Unit Rise}} \qquad \frac{\text{Finished Stairwell Length(FSL)}}{\text{Unit Run}}$$

So to solve for FSL, FSL = Unit Run x HFCD
Unit Rise



Straight Stairs

Samples and least costly requires a long hallway which may sometimes be a disadvantage.
May have walls on both sides (closed string) or may have open balustrade on one side (open string).

Height Floor to Floor M	Number of Risers	Height of Risers R	Width of Treads T	Total Run L	Minimum Headroom Y	Well Opening U
8'0"	12 13 13	8" 7 3/8" + 7 3/8" +	9" 9 1/2" 10"	8'-3" 9'-6" 10'-0"	6'-4" 6'-4" 6'-4"	8'-1" 9'-2 1/2" 9'-8 1/2"
8'6"	13 14 14	7 7/8" – 7 5/16" – 7 5/16" -	9" 9 1/2" 10"	9'-0" 10'-3 1/2" 10'-10"	6'-4" 6'-4" 6'-4"	8'-3" 9'-4" 9'-10"
9'0"	14 15 15	7 11/16" – 7 3/16"	9" 9 1/2" 10"	9'-9" 11'-1" 11'-8"	6'-4" 6'-4" 6'-4"	8'-5" 9'-6 1/2" 9'-11

3. The headroom clearance shall be maintained over a landing that is at the top or bottom of a stairway for a minimum distance of 36 inches in the direction of travel of the stairway.

(e) Uniformity. 1. Within a stairway flight, tread depths and riser heights may vary by a maximum of 3/16 inch.